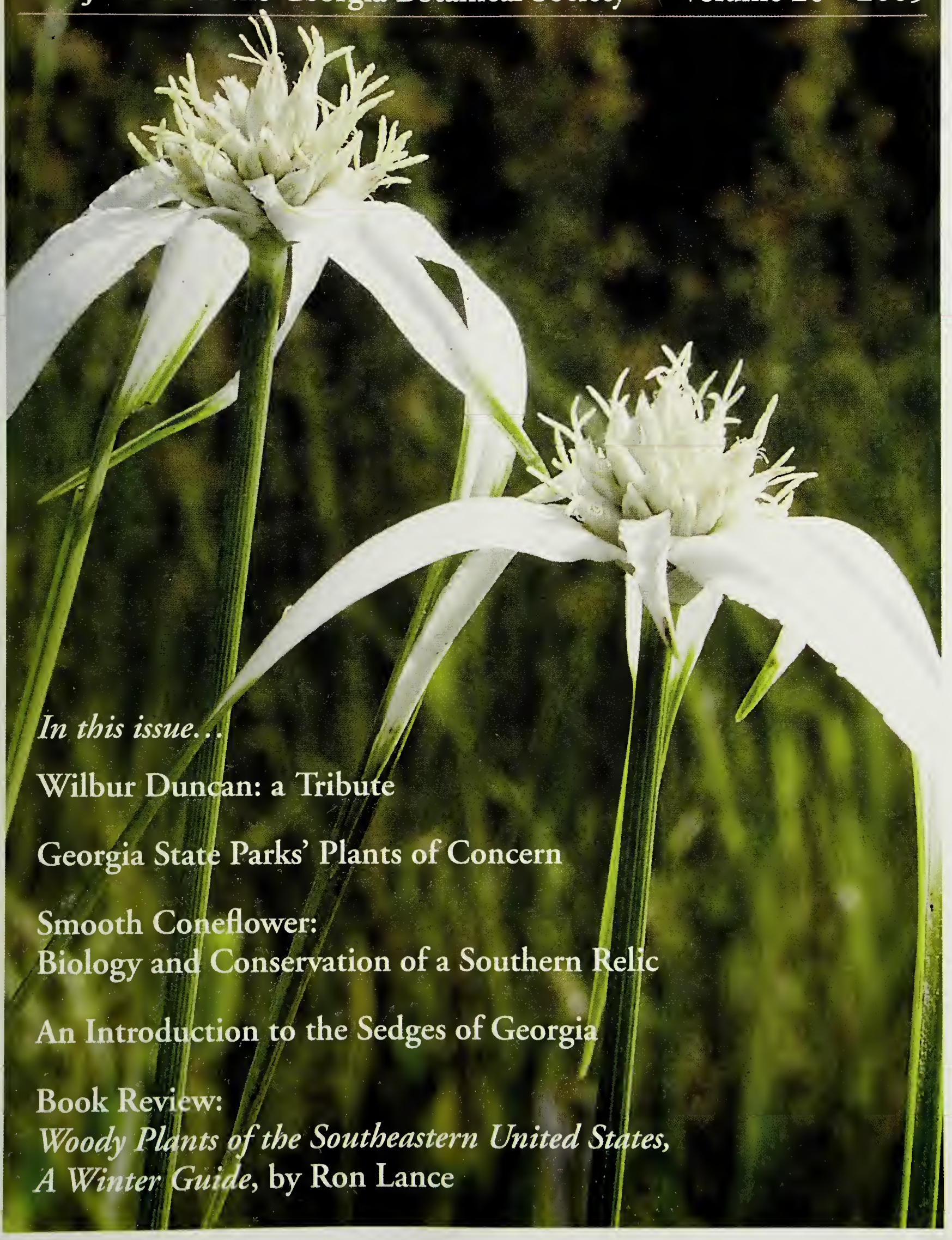
# Tipularia

The Journal of the Georgia Botanical Society Volume 20 • 2005



*In this issue...*

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*Tipularia* is published once a year by the Georgia Botanical Society to foster knowledge of and interest in the state's native plants and related subjects



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### Membership

The Georgia Botanical Society is open to all persons interested in the botany of Georgia. Annual dues: individual or family, $25; group, $30; student, $10. Send address and check payable to Georgia Botanical Society to Anita Reaves (2718 Stillwater Lake Lane, Marietta, GA 30066–7906). Members receive *Tipularia* without extra charge. Persons wishing only to receive the magazine may become *Tipularia* associates for $10 per year. Single copies, when available, may be ordered from Richard Ware (2 Idlewood Court NW, Rome, GA 30165–1210), (1991 and before, $5; 1992 and after, $10).

### Editorial information

*Tipularia* strives to combine the scientific authority of a botanical journal with the readability of a magazine. Some articles are assigned; unsolicited manuscripts are welcomed for consideration. *Tipularia* is unable to pay for articles or art, but there is no charge for publication of them.

### Cover

*Rhynchospora colorata* by Richard Carter

# Wilbur Duncan

## October 15, 1910–March 25, 2005

## *a tribute*

*Here's to you, Wilbur!*

To many of us, you were "Mr. 'Georgia Taxonomy.'" We deeply appreciate all you did to illuminate our state's botanical treasures. For years to come, your legacy will enrich the lives of everyone with an interest in plants of Georgia, the southeast and east, and the seacoast from Texas to Canada. We stand in awe of the fact that you continued to work, with Marion, until you were well past 90, and we look forward to the publication of Shrubs of the Southeastern United States.

We loved your eagerness to help people learn. You paid real attention to small children as well as friends, colleagues, and students.

We loved your gentle nature. It did not keep you from taking firm stands, especially where the protection of the environment was concerned.

We loved your appreciation of beauty in all its forms, music, art, science, sports, everyday life. It takes a special person to find beauty in splitting wood, one of your favorite pastimes.

We loved your vitality. We loved your love of truth.

We loved you as an inspiring role model.

With pride, we dedicate this issue of *Tipularia* to you.

*John Garst*
For the members of the Georgia Botanical Society

Cloudland Canyon State Park

Georgia Department of Natural Resources

# Georgia State Parks' Plants of Concern

By Carol Schneier &
Cindy Reittinger

The State Parks' Plants of Concern (SP-POC) project is an ongoing effort to inventory rare plants in the state parks. Initiated in 2002 the project is a partnership between the Georgia Botanical Society (GBS) and two agencies within the Georgia Department of Natural Resources—Georgia State Parks & Historic Sites (PHS) and the Georgia Natural Heritage Program (GNHP).

With more than 80,000 acres to preserve and over twelve million visitors a year to serve, PHS staff have limited time and resources to devote to site inventories. They also have limited technical expertise to identify rare plant species and therefore rely heavily on GNHP. The two agencies already work closely on protected species issues. GNHP, however, has limited staff resources with only two botanists to cover the entire state.

The GBS has been able to assist both agencies by supplying volunteers with strong plant identification skills to conduct fieldwork at parks where inventory work is needed. GNHP staff have provided volunteers with the necessary background information they need to get started. As the agency responsible for maintaining the database of plants and animals of concern in Georgia, they have records showing what plants of concern have already been found in each park, as well as what has been found in the county where each park is located.

*Stewartia malacodendron* Hugh & Carol Nourse

## Georgia's Rich Diversity

Georgia is the largest state east of the Mississippi and ranks sixth in the country in overall biological diversity. Geographically it is at the edge of many species range. The range of many northern species extends south into the Blue Ridge and Ridge and Valley regions, while south Georgia's Coastal Plain is the northern limit for many subtropical Florida species. From the mountains to the coast, Georgia's diverse natural communities offer a multitude of habitats for plants and animals. The state's natural biodiversity ranks second in the nation in number of amphibians, third in the number of freshwater fishes, seventh in the number of reptiles and seventh in the number of vascular plants.

Unfortunately, Georgia also figures prominently in the number of species at risk ranking

*Sabatia capitata* Richard Reaves

*Delphinium tricorne* Richard Reaves

fifth in the country for the percent of overall species at risk. The state is third in the percent of fish species at risk (16.8%); fifth in mammal species at risk (14.1%); seventh in reptiles at risk (14.5%); eighth in bird species at risk (2.7%), and eighth in vascular plants at risk (11.1%).

Georgia has more than 3500 vascular plant species. Of these, approximately 1/3 appear on the GNHP's lists of concern:

- State Protected List (includes State and Federally listed plants)—105 species
- Tracking List (generally twenty or fewer populations statewide)—644 species
- Watch List (more documentation needed to establish conservation status)—334 species

## SPPOC Beginnings

SPPOC began with a small article in the July 2002 *Bot Soc News* requesting volunteers to identify protected plants in state parks. The enthusiastic response generated by the article brought together representatives from GBS, PHS and GNHP to form the existing partnership. Together they laid out plans for the project including a one-day training session held in January 2003 at Panola Mountain State Conservation Park. The training, attended by more than twenty potential volunteers, covered the project goals, procedures for conducting fieldwork, guidelines for documenting findings, as well as how to use a GPS unit to record the location of any findings. With this as a starting point, GBS volunteers were charged with verifying the records for known rare plants and adding new records as they surveyed their park.

Interested volunteers selected a state park to work with and received a notebook for their park complete with report forms, permits, a topographic map of the park, a list of protected plants and species of concern known to be in the park, and a county list to be used to determine potential species. For most volunteers, the statewide list of close to one thousand plants of concern was narrowed down to a couple of dozen plausible candidates which might grow at that park.

Each Botanical Society volunteer agreed to spend at least two years with their park thereby allowing two seasons of effort to find any given plant that could potentially occur in the park. After an initial visit to meet park staff, volunteers set to work getting familiar with the habitats in their park so they could narrow down possibilities and research potential finds. Research included identifying the best time to identify the plants and learning to distinguish them from look-alike species.

## Findings After Two Years

Surveys have been initiated at eleven parks and work at three sites has been completed. Although no new finds were made at one of the completed sites, this knowledge is still helpful.

*Croomia pauciflora* Leslie Edwards and Steve Bowling

At larger botanically rich parks, efforts have continued beyond the originally allotted two years.

Since the project began, twenty-nine species of concern have been added to the plant lists kept for each park and the locations for six previously known species have been identified and mapped. Most of the list additions were new findings made by volunteers while others were a result of outside research conducted at parks or discoveries by GNHP and Park staff. In more than one case a plant added to the list had been known about for years, but had never been documented.

Reports of all new findings have been submitted to the GNHP for verification and entry into the statewide database. The data submitted includes the following information:

- Plant name
- Location information including: a GPS reading, written directions to the site, a sketch of the site, and a topo map with the site indicated
- Description of habitat
- Notes about population size, health, etc.
- Photo of plant

For most plants, a photo was sufficient to verify the identification. However, the methods outlined in the project procedures allow a volunteer to collect hard-to-identify plants if the population is large enough. The necessary collection permits required by the State were issued to all project volunteers before they began their fieldwork.

The following is a list of new findings and previously undocumented finds added to Georgia's State Parks Plants of Concern List and the park(s) where they were found.

*Hexastylis shuttleworthii var. harperi* Tom Patrick

*Agalinis decemloba*, bicolor Richard Reaves

## State Protected Species

*Croomia pauciflora*, Croomia; Providence Canyon

*Cypripedium acaule*, Pink Ladyslipper; Black Rock Mountain, Hart, James H. Floyd, Red Top Mountain, Sweetwater Creek, Unicoi

*Hexastylis shuttleworthii var. harperi*, Harper's Wild Ginger; Victoria Bryant

*Sabatia capitata*, Cumberland Rose Gentian; Cloudland Canyon

*Sarracenia minor*, Hooded Pitcherplant; Laura S. Walker, Stephen C. Foster

*Scutellaria montana*, Large-flowered Skullcap; James H. Floyd

*Shortia galacifolia*, Oconee Bells; Tallulah Gorge

*Stewartia malacodendron*, Silky Camellia; Mistletoe

## Tracking List Species

*Aesculus glabra*, Ohio Buckeye; Cloudland Canyon

*Aesculus parviflora*, Bottlebrush Buckeye; Providence Canyon

*Agalinis decemloba*, Purple Foxglove; Cloudland Canyon

*Carex appalachia*, Appalachian Sedge; FD Roosevelt

*Carex torta*, Twisted Sedge; Cloudland Canyon (pending verification)

*Delphinium tricorne*, Dwarf Larkspur; Cloudland Canyon, James H. Floyd

*Diarrhena americana*, American Dropseed; Cloudland Canyon

*Erigenia bulbosa*, Harbinger-of-Spring; Cloudland Canyon

*Glyceria septentrionalis*, Floating Manna-grass; Watson Mill Bridge

*Lycopodium clavatum*, Ground Pine; Black Rock Mountain

*Monotropsis odorata*, Sweet Pinesap; Tallulah Gorge

*Panax quinquefolius*, American Ginseng; Cloudland Canyon, James H. Floyd

*Quercus chapmanii*, Chapman Oak; Crooked River

*Saxifraga careyana*, Carey saxifrage; Cloudland Canyon

*Trichomanes petersii*, Dwarf filmy fern; Cloudland Canyon

*Trillium sulcatum*, Barksdale Trillium; Cloudland Canyon

*Vitis palmata*, Catbird Grape; Crooked River (pending verification)

## Watch List Species

*Krameria lanceolata*, Sandbur; Little Ocmulgee

*Magnolia pyramidata*, Pyramid Magnolia; Providence Canyon

*Trillium underwoodii*, Dwarf Mimic Trillium; Providence Canyon

*Stewartia ovata*, Mountain Camellia; Cloudland Canyon

*Agalinis decemloba*, normal Richard Reaves

*Agalinis decemloba*, white Richard Reaves

## Benefits of the Project

The timing for this project has proven to be serendipitous. Last fall PHS decided to begin developing management plans for each state park and efforts are underway to complete plans at two parks in 2005. The information collected by GBS volunteers will be very useful in developing plans at those sites where survey work was done. Park Managers can incorporate rare plant information into their plans in a variety of ways. They may choose to highlight the park's botanical treasures in interpretive efforts and/or establish a plan to protect these rare plants. Protection may include discouraging the encroachment of invasive exotic species, restricting visitor access, monitoring the sites and minimizing adverse impacts. The information may also determine the placement of future developments such as new trails, campgrounds, picnic shelters and restrooms.

In these times of tight budgets, the SPPOC program is an excellent example of a working partnership between state government agencies and private citizen organizations. Each group cannot complete the project alone but, by sharing resources, time and skills, are able to accomplish great things.

*Shortia galacifolia* Richard & Teresa Ware

*Cypripedium acaule* Brad Sanders

Echinacea laevigata

Heather Alley

# Smooth Coneflower: Biology and Conservation of a Southern Relic

**By Heather Alley**

## Introduction

The smooth coneflower, *Echinacea laevigata* (Boyton & Beadle) Blake, is one of Georgia's eighteen federally listed endangered plant species. There are only five populations left in our state in Stevens and Habersham Counties. While there is little published on this southeastern Piedmont species, the genus is well studied. *Echinacea*, an exclusively North American genus in the sunflower family, ranges from the Midwest to the eastern United States. Originally treated as having nine species by McGregor (1968), *Echinacea* has recently been revised to include four species and four to eight varieties using molecular techniques (Binns et al 2002; Mechanda et al 2004). The most widespread species, *E. angustifolia*, extends from southern Texas north into Canada (McGregor 1968). Along with *E. laevigata*, *E. tennesseensis*, a central Tennessee cedar glade endemic, is also endangered. Interest in *Echinacea* stems from its long history as a medicinal herb, and more recently from its popularity as a garden ornamental.

*Echinacea laevigata* is historically documented from Pennsylvania, Maryland, Virginia, North Carolina, South Carolina, Georgia, Alabama, and Arkansas, although accounts of Maryland and Alabama occurrences may not be from authentic *E. laevigata* populations. It is currently known to exist in southern Virginia, North Carolina, South Carolina and Georgia. Of the fifty-seven known historical populations, twenty-one (thirty-six percent) remained at the time of its federal listing in 1992. The causes for most of the extirpations are unknown. Only one of the remaining populations is increasing in size, seven are stable, and thirteen are declining. Most populations are very small with half containing less than 100 plants (U.S. Fish and Wildlife Service 1995). The largest and likely healthiest populations are in North Carolina. The majority of known populations exist on roadsides and utility rights-of-way, while the few undisturbed populations are declining in number and size as encroachment by woody species shades out the understory (Emanuel 1996; Gaddy 1991).

## Biology

Smooth coneflower is a perennial with thick fleshy roots. It flowers in late May through July (Cronquist 1980, Radford et al. 1968). While its primary mode of reproduction is sexual, vegetative reproduction from rhizomes has been observed making it difficult to distinguish genetically distinct individuals (Apsit and Dixon 2001). In McGregor's 1968 pollination study, all species of *Echinacea* were found to be self-sterile when flower heads were bagged. More recently, *E. purpurea* was found to be primarily outcrossing, but partially self-compatible when hand-pollinated with pollen from the same flower head (Leuszler et al. 1996). *Echinacea laevigata* has no known specialized pollinators or dispersal mechanisms. Although the species germination requirements have not

*Echinacea laevigata* Heather Alley

been studied, bare soil is likely required, and soil rich in magnesium and/or calcium, may play a role (Gaddy 1991). However, plants are easily grown from seed and maintained in average garden soil.

Populations of *Echinacea laevigata* sampled from North Carolina, South Carolina, and Virginia were found to have moderate levels of genetic diversity, comparable to that of the widespread congener *E. angustifolia*. Because of the unequal partitioning of genetic variation among populations, each population contributes to the overall genetic variation for the species. This partitioning has implications for the collection of material for ex situ conservation and reintroduction, as populations may be locally adapted (Apsit & Dixon 2001).

## Habitat

*Echinacea laevigata* is associated with calcium and magnesium rich soils associated with underlying mafic rock: amphibolite, dolomite, or limestone in Virginia; gabbro in Virginia and North Carolina; diabase dikes in North Carolina and South Carolina; and marble in Georgia and South Carolina (U.S. Fish and Wildlife Service 1995). In Georgia and South Carolina, all natural populations are associated with soils of the Poor Mountain-Chauga Belt (Gaddy 1991). Smooth coneflower community types are characterized as xeric hardpan forest, diabase glades, or dolomite woodlands in the case of Virginia populations (Schafale and Weakley 1990). Openings may be maintained by shallow soil and harsh edaphic conditions associated with aspect and/or poor moisture retention of the soil. Smooth coneflower is found in meadows, fields, roadsides, utility rights-of-way and open woodlands. Historically, they were likely found in prairie habitats and post oak-blackjack oak savannas, which were maintained by lightning fires and burning performed by native Americans (Barden 1997; Komarek 1974). In a thorough site survey conducted in 1990, all sites were found to have less than thirty percent tree cover (Gaddy 1991). Plant species associated with *E. laevigata* populations vary with location. A list of vascular plants associated with Piedmont prairies is provided by Davis et al. (2002).

## Threats

Smooth coneflower is threatened primarily by habitat loss from development and fire sup-

pression, as well as by collecting and genetic decline. The vulnerable location of many populations in human-use areas (roadsides, right-of-ways, fields) leaves their future uncertain. Populations located on private land have little legal protection under the Endangered Species Act.

The Forest Service began intensive fire suppression activities in the early twentieth century. The interruption of this natural process has greatly decreased the proportion of early successional habitat in southeastern forests (Komarek 1974). In the absence of fire, early successional species that require disturbance to create forest openings have been restricted to openings created by roads, fields, and utility rights-of-way. It is thought that fire suppression is a significant cause for the decline of the disturbance-requiring smooth coneflower (Gaddy 1991).

Wild harvest of many *Echinacea* species for their medicinal value long ago reached unsustainable levels and continues to increase. As early as the late nineteenth century, concern over collection of *E. angustifolia* and *E. pallida* began to arise as single orders for the herb ranged from 200 to 40,000 pounds (Foster 1991). In 1989, it was estimated that two million *E. purpurea* roots were harvested that year (Kindscher 1989). Demand and concern continue for many species throughout their ranges, encouraging cultivation of several species. While the wild collection of whole *E. laevigata* plants has not been observed, the threat is real. Other unusual, rare or endemic *Echinacea* species have been negatively impacted due to wild collection, including the endangered *E. tennesseensis*. Public interest in all species of *Echinacea* for their ornamental value also threatens the plant's future (Foster 1991, Sheldon et al. 1997). On several occasions, flowers or seed have been removed from entire roadside populations of *E. laevigata* (C. Wentworth, U.S. Forest Service, personal communication).

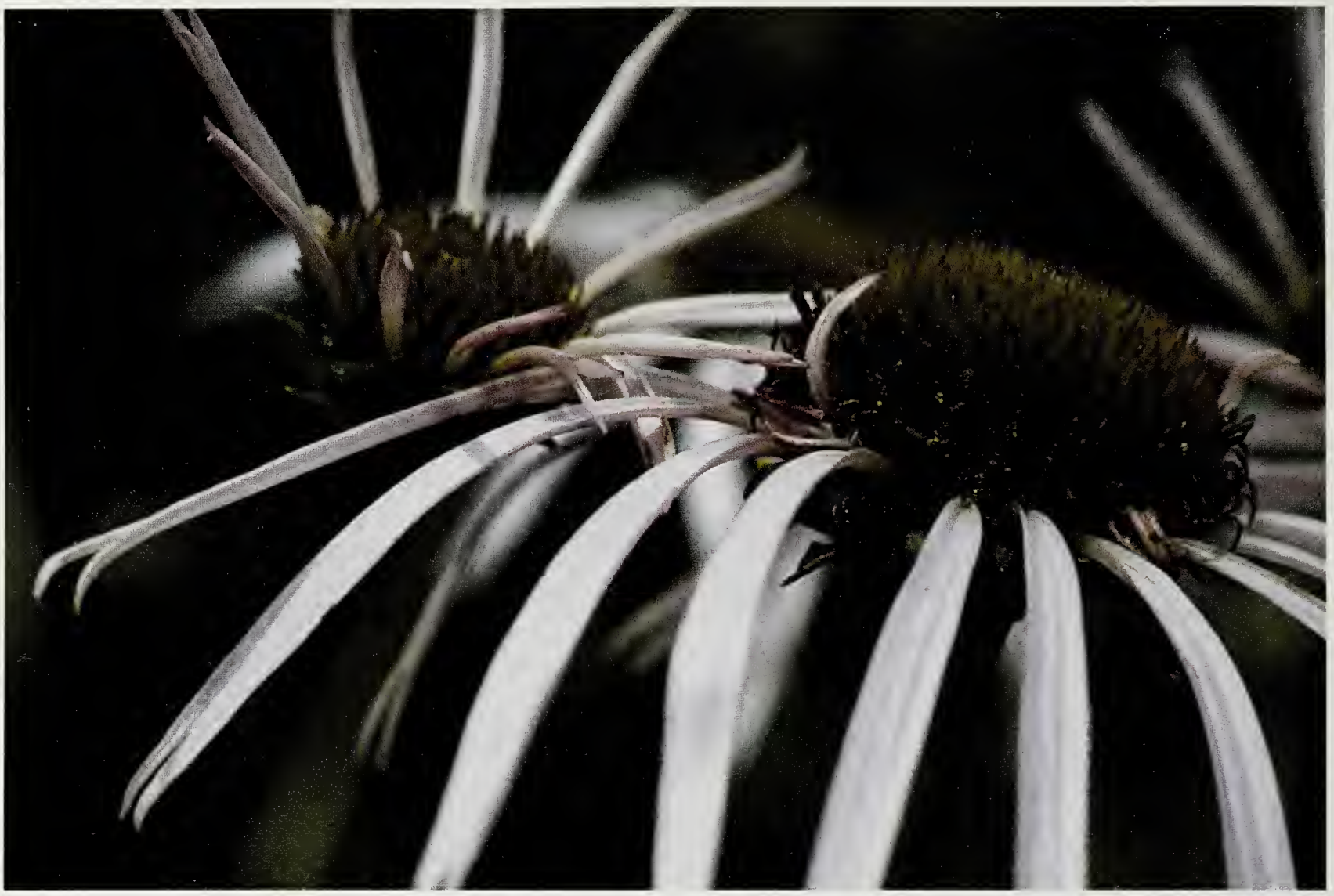
*Wild harvest of many Echinacea species for their medicinal value long ago reached unsustainable levels and continues to increase.*

Because most *E. laevigata* populations are very small, they are at risk of genetic decline from inbreeding depression. Habitat fragmentation reduces the flow of genes between populations reducing the effective population size of disjunct populations (Wright 1943). Small population size has been shown to increase the likelihood of population decline and extinction (Ellstrand and Elam 1993).

## Management and Recovery

Protective management, restoration and ex situ conservation are vital to the preservation of smooth coneflowers and are called for by the U.S. Fish and Wildlife Service Recovery Plan (1995). In Virginia, The Nature Conservancy and the Virginia Department of Conservation and Recreation developed a landowner contract program to encourage the voluntary protection of privately owned populations. The Forest Service in North Carolina works with the North Carolina Department of Transportation to ensure safe roadside mowing regimes. Ex situ conservation at the North Carolina Botanical Garden involves maintaining a collection of live plants and seed storage. Seeds are also stored at the U.S. Department of Agriculture's national seed storage lab in Colorado. Ex situ collections are merely a safety net should wild populations become extirpated (Komarek 1974, U.S. Fish and Wildlife Service 1995). In Georgia, most populations are on U.S. Forest Service land where plants are monitored and protected from destructive mowing and road grading activities.

Smooth coneflower management requires clearing of competing vegetation by various means. Several season-specific clearing meth-



*Echinacea laevigata* Heather Alley

ods, including burning, hand-clearing and mowing, have been evaluated by land managers. At a Virginia site owned by The Nature Conservancy, mowing in 1987 yielded a near one hundred percent increase in stems after four years. The North Carolina Department of Agriculture's Plant Conservation Program began a prescribed burning program in 1994 for the largest known population, which seems to have benefited the population. Similarly, prescribed burning was initiated for Georgia populations on U.S. Forest Service land and results are being monitored. Mechanical removal of woody species on a four year cycle was chosen by the U.S. Army Corps of Engineers after evaluation of management alternatives to prescribed burning (Komarek 1974, U.S. Fish and Wildlife Service 1995). In a controlled experiment testing various clearing methods, including hand-clearing of trees, winter burning, and leaf blowing the forest floor, tree removal resulted in the greatest increase in blooming and leaf production (Emanuel 1996).

## Smooth Coneflower Conservation in Georgia

Smooth coneflower recovery is one of seven priority projects of the Georgia Plant Conservation Alliance (GPCA, www.uga.edu/~gpca). Members of GPCA's smooth coneflower committee, made up of botanists, ecologists, and horticulturists from the Department of Natural Resources, U.S. Forest Service, and botanical gardens, collaborate on monitoring populations, prescribed burning, reintroduction and restoration, safeguarding, research, and education.

In 1999, GPCA was awarded a grant by the Turner Foundation to support graduate student research, allowing me to join the team and begin researching methods for reintroducing populations of smooth coneflower. Nearly every smooth coneflower population in Georgia is located on vulnerable roadsides or in utility rights-of-way. These artificially maintained openings often serve as refugia for early successional plant species, but leave them at risk from

maintenance activities like mowing, bush-hogging, or worse, herbicide spraying. Furthermore, by their nature, these openings receive heavy human traffic, increasing the likelihood of wild collecting and invasive plant encroachment. Therefore, establishing populations for safeguarding in secluded areas away from negative human impact is a top priority. Reintroducing, introducing, or augmenting plant populations is quite complicated. Variables include the genetic integrity of the stock material, site selection, logistics, price, labor involvement, herbivory, disease, long term monitoring and management. When putting forth such an effort, practitioners want some assurance that the plants will persist and reproduce.

*While long term survival will be the ultimate test, high survival rates documented in the first two years of the experiment suggest that reintroduction will be a viable conservation tool for this species.*

Our experimental reintroduction of smooth coneflower was very encouraging. While long term survival will be the ultimate test, high survival rates documented in the first two years of the experiment suggest that reintroduction will be a viable conservation tool for this species. We tested the effectiveness of several planting methods for establishing populations in the wild. The plants had excellent initial survival rates ranging from sixty to ninety percent in the first two seasons. They did well regardless of spacing, presence or absence of soil amendment, and age at time of transplant. This result affords flexibility in planning the logistics of future reintroduction efforts. Interestingly, although deer do not browse wild smooth coneflowers to any significant degree, they presented the biggest threat to reintroduced plants. This makes site selection even more critical as deer avoided the steeper, more forested site, while they decimated plants at the more grassy, open, flat site. With careful site selection and exclusion devices, this deer grazing can be minimized (Alley and Affolter 2004).

Based on the apparent success of the experimental reintroduction, GPCA is now making plans for a smooth coneflower habitat restoration effort. The restored habitats will be located in Stephens County on Currahee Mountain in areas thought to be historical oak-pine savannas. Smooth coneflower savannahs will be created using prescribed fire to open the landscape and allow native prairie grasses and forbs to colonize, and by introducing associated plant species with seed and propagated plants. This safeguarding community will serve as a refuge for smooth coneflower as well as some of its rare or unique associates, such as Georgia aster (*Aster georgianus*) and curlyheads (*Clematis ochroleuca*).

To promote public awareness and involvement, smooth coneflower habitat display gardens have been created at the State Botanical Garden of Georgia in Athens, and at the visitor's center at Tallulah Gorge State Park in Tallulah Falls. These gardens feature smooth coneflowers growing among native grasses and wildflowers associated with their unique oak-pine savanna habitat.

Smooth coneflowers are relics of a bygone southern landscape, survivors of an era when open savannas migrated across the land in the wake of wildfire. Today, fire suppression threatens the species future, while civilization's disturbance of natural areas has also helped keep them from extinction. Human intervention has led to the species decline. Let us hope that human intervention can help bring them back.

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# An Introduction To The Sedges Of Georgia

Figure 1. Capitate inflorescence of *Rhynchospora colorata* subtended by showy, green-tipped, white bracts.


## Richard Carter

Photography by Richard Carter unless otherwise indicated


## Introduction

The sedge family, or Cyperaceae, is the third largest monocot family, consisting of an estimated 5000 species in 104 genera (Fig. 1).[1, 2] The largest genera with approximate numbers of species are *Carex*, 2000 spp.; *Cyperus*, 550 spp. (excluding *Kyllinga* and *Pycreus*); *Fimbristylis*, 300 spp.; *Rhynchospora* and *Scleria*, 250 spp. each; *Eleocharis*, 200 spp.; and *Bulbostylis*, *Pycreus* and *Schoenus*, 100 spp. each.[1] Sedges are grass-like flowering plants with linear leaves, parallel venation, and small, mostly wind-pollinated flowers. Although sedges have traditionally been viewed as close relatives of the grasses (Poaceae),[3] recent cladistic analysis using molecular and morphological data shows they are more closely allied with the Juncaceae and Thurniaceae.[4]

Sedges, grasses, rushes and other similar

Table 1. A comparison of the graminoid families *Cyperaceae*, *Poaceae* and *Juncaceae*.[3]

| *Cyperaceae* **The Sedge Family** | *Poaceae* **The Grass Family** | *Juncaceae* **The Rush Family** |
|---|---|---|
| • Stems usually three-angled (but sometimes terete, quadrangular, or lenticular) | • Stems terete | • Stems terete |
| • Stems usually with solid pith | • Stems with solid nodes and hollow internodes | • Stems with solid pith |
| • Leaf sheaths closed | • Leaf sheaths open | • Leaf sheaths open |
| • Inflorescence a complex of spikelets (simple spikelet in *Eleocharis*) | • Inflorescence a complex of spikelets | • Inflorescence a complex of cymes |
| • Perianth of 1–many bristles or hairs, or absent | • Perianth hardly evident, apparently reduced to scale-like palea (outer series?) and tiny lodicule (inner series) | • Perianth of six scale-like parts in two series |
| • Stamens 3 (1-2, rarely 6) | • Stamens 3 or 6 (rarely 1-2) | • Stamens 6 (rarely 3) |
| • Pistil of 2-3 fused carpels | • Pistil of 2(3) fused carpels | • Pistil of 3 fused carpels |
| • Fruit an achene | • Fruit a caryopsis (grain) | • Fruit a capsule |

kinds of monocot plants with small, inconspicuous flowers and linear leaves are grouped informally as graminoids. Although exceptions do occur, the anonymous rhyme "sedges have edges, rushes are round, grasses are hollow right up from the ground" does have value in enabling beginners to grasp general differences in vegetative structure among these families (Table 1). Although most sedges have three-angled stems, hence "sedges have edges," some do not. For example, the stems of *Dulichium arundinaceum* (L.) Britt. and many *Eleocharis* species are round in cross section.

## Common Names Can Be Confusing!

Common names are often derived uncritically and can be confusing, especially for grasses, rushes and sedges. The so-called bulrushes (*Scirpus* spp., *Schoenoplectus* spp.), spike-rushes (*Eleocharis* spp.), and beak-rushes (*Rhynchospora* spp.) are actually sedges. Likewise, the cotton-grasses (*Eriophorum* spp.), umbrella-grasses (*Fuirena* spp.), and sawgrass (*Cladium jamaicense* Crantz) are sedges, and the nut-sedges (*Cyperus esculentus* L., *C. rotundus* L.) are often called "nut-grasses." Universality and relative lack of ambiguity are major advantages of scientific names. Because many graminoids, sedges included, are relatively inconspicuous and escape all but passing notice, most do not have common names. Therefore, scientific names are employed liberally in this article.

## Uses of Sedges by Humans

Although not generally recognized for their economic importance and beneficence, sedges have been used by humans for thousands of years. The English word "paper" is derived from "papyrus," the Latin name for the sedge *Cyperus papyrus* L., first exploited ca. 4500 years ago by the ancient Egyptians to manufacture paper.[5] Another sedge, *Schoenoplectus corymbosus* (R. & S.) Raynal was employed in funeral wreaths by the ancient Egyptians.[6]

Chinese water-chestnuts, widely consumed in oriental cuisine, are the edible starchy tubers of the aquatic spikerush, *Eleocharis dulcis* L., grown in paddies in Asia.[7] *Cyperus esculentus*

Figure 2. A portion of the stem of *Dulichium* showing nodes, internodes, closed leaf sheaths, and leaf blades.

var. *sativus* Boeck., yellow-nutsedge, one of the oldest crops in Egypt, is cultivated in Africa, Asia and southern Europe for its tubers called *chufas, tiger nuts, Zulu nuts* or *earth almonds*, which are rich in starch, sugar and fat and have a nutty flavor when roasted.[6] Chufas are also made into flour and the Spanish drink *horchata de chufa*[6] and are the source of a non-drying oil of some economic value.[7] Yellow nut-sedge is also planted for its tubers to provide food for wildlife.[8] The rhizomes of bulrushes (*Schoenoplectus* spp.) were eaten by native Americans, and robust bulrushes, like *Schoenoplectus californicus* (C.A. Mey.) Soják, have been exploited to construct houses and boats.[6] Stems, leaves, or fibers of many sedges are used as materials for weaving, especially in undeveloped parts of the world.[2] For example, the stems and leaves of various bulrushes (*Scirpus* spp., *Schoenoplectus* spp.) including *Scirpus americanus* Pers., commonly called chairmaker's rush, are woven into baskets, mats, and chair seats, and fibers from *Fimbristylis umbellaris* (Lam.) Vahl are used as material for weaving in Asia.[6]

A surprising number of sedges are cultivated as ornamentals. Umbrella sedge (*Cyperus alternifolius* subsp. *flabelliformis* Kük.) has been grown in water gardens and as a pot-plant for more than 200 years, and papyrus (*Cyperus papyrus*), dwarf papyrus (*Cyperus prolifer* Kunth), and certain bulrushes (*Scirpus* spp., *Schoenoplectus* spp.) are cultivated in water gardens and ponds.[9] A number of *Carex* spp. are planted in woodland gardens, and *Cyperus albostriatus* Schrad. and *Isolepis cernuus* (Vahl) Roem. & Schult are used in pots and hanging baskets.[9] The bulrush *Schoenoplectus lacustris* (L.) Palla has been employed in Germany and the Neth-

Figure 3. Habit of *Eleocharis tuberculosa* showing apparently leafless stems.

erlands for water purification, and certain *Fimbristylis* species are indicators of copper deposits in Australia.[6] Bryson and Carter[10] have accumulated a list of more than 150 species of Cyperaceae cultivated as ornamentals or otherwise, which they attribute to be an important factor in their dispersal as weeds, and Simpson and Inglis[2] have compiled a comprehensive checklist of sedges exploited by humans.

## Sedges as Weeds

Many sedges are adapted to open, sunny sites with reduced competition from taller shading trees and shrubs. Such plants are called heliophytes, and their habitats are often dependent upon natural or artificial disturbance. These sedges have intrinsic characteristics such as high reproductive output, rapid growth, vegetative proliferation, and extended seed dormancy that promote population expansion after disturbance, and they probably originally evolved as colonizers following disturbance.[11, 12, 13] Although there is a tendency to think in terms of catastrophic perturbations, more subtle and continual natural processes provide open areas for colonization by such species, e.g., exposed bars and banks along streams and coasts.[12]

The same characteristics that make sedges successful colonizers following natural disturbance enable them to occupy habitats artificially disrupted and maintained by humans, such as agricultural fields, lawns, and gardens.[12] Such opportunistic plants, often called weeds, are usually not problems so long as they are elements of their naturally co-evolved communities. However, when dispersed by humans from their native ranges and communities, they can adversely affect natural ecosystems, agriculture, and other societal interests. Moreover, habitat destruction and disturbance of natural ecosys-

Figure 4. Inflorescence of *Cyperus strigosus* showing stem, leafy bracts, and inflorescence rays.

Figure 5. Close-up of inflorescence of *Cyperus difformis* with six spikes visible, each composed of numerous small spikelets.

tems by humans creates the conditions necessary for such plants to survive and establish a "beach head" for subsequent dispersal during the early stages of naturalization and invasion.

Holm et al.[14] cited purple nut-sedge (*Cyperus rotundus*) as the world's worst weed and listed other sedges among the forty worst weeds: *Cyperus esculentus* (16th), *C. difformis* L. (32nd), *C. iria* L. (33rd), and *Fimbristylis miliacea* (L.) Vahl (40th), all of which have been introduced into Georgia. Additionally, a number of other native and introduced sedges are considered by many to be weeds of agriculture, lawns and gardens, turfgrass, or natural areas.[15]

## General Structure

Sedges are widely believed to be taxonomically challenging. This is largely due to extreme reduction of flowers and associated structures in both number and size and the inherent difficulty in handling and describing such small, specialized parts. Based mainly upon the organization of complex inflorescences and small fruits (achenes) and associated parts (e.g., perianth, tubercle), reliable identification requires reproductively mature specimens with fully developed spikelets and achenes, the use of a good hand lens or a dissecting microscope, and the ability to manipulate and dissect fine structures. A glossary is provided at the end of this article to assist readers with some of the specialized terminology of sedges.

Figure 6. Solitary, terminal spikelet of *Eleocharis equisetoides* showing spiral scales.

**Habit.** Sedges are morphologically diverse and, depending upon the species, may have annual or perennial habits. Most species are perennial herbs persisting and spreading vegetatively by rhizomes, stolons, corms, or tubers.

**Stems and leaves.** Typically, stems are trigonous with three sides and three angles; however,

Figure 7. Individual spikelet of *Cyperus sanguinolentus* isolated to show distichous scales.

Figure 9. In *Cyperus echinatus* the spikelets fall intact—achenes, scales and all—and the entire spikelet is dispersed as a unit. Note scattered, intact spikelets.

Figure 10. In *Cyperus odoratus* the spikelets break apart into one-fruited segments, the unit of dispersal.

Figure 8. Portion of inflorescence of *Cyperus haspan* showing the sequential separation of scales and fruits from base to apex of spikelet. In this species the fruits are dispersed individually. Note two white fruits of central spikelet, exposed after separation of their subtending scales.

in *Dulichium* stems are round in cross section (terete), and in *Eleocharis* they can be terete or two-, three-, four- or more-angled. Leaves of sedges arise at intervals along a leafy stem (e.g., *Dulichium, Scirpus, Bolboschoenus*) or are clustered near the base of the plant (e.g., *Cyperus, Kyllinga*). They have closed sheaths (Fig. 2) with generally lanceolate to linear, grass-like blades. Unique within the family, plants of *Eleocharis* have leaves reduced to bladeless sheaths and, thus, appear leafless (Fig. 3).

**Inflorescence.** Some genera such as *Cyperus* and *Kyllinga* have prominent leafy bracts positioned below the inflorescence (Fig. 4). This feature is perhaps best developed in the white-topped sedges (*Rhynchospora* section *Dichromena*), characterized by dazzling white bracts with contrasting green tips (Fig. 1). The basic unit of the sedge inflorescence is

Figure 11. A fertile stem of *Carex glaucescens* showing plume-like, terminal staminate spikelet and three pistillate spikes below; each pistillate spike consists of numerous perigynia with each perigynium enveloping a pistillate flower. The exposed stamens of the staminate spikelet facilitate pollination by wind.

the spikelet. Generally, spikelets are organized into paniculate, cymose, umbellate or spicate clusters (Fig. 5), except *Eleocharis* with the inflorescence reduced to a single spikelet (Fig. 6). Essentially, each spikelet consists of one or more tiny flowers subtended by small bracts called scales. The scales and flowers may be spirally arranged (Fig. 6) or distichous (Fig. 7). In some sedges, the fruits are dispersed individually as they fall away one-by-one with their associated scales from the base to the apex of the spikelet (Fig. 8). In others, the spikelets separate as intact units—scales, fruits and all (Fig. 9), or the spikelet axis breaks apart into one-fruited segments, each segment having a portion of the axis, a scale, and a fruit (Fig. 10). The flowers in most genera of Cyperaceae are perfect (bisexual) with both stamen and pistil. However, *Carex*, *Cymophyllus* and *Scleria* have imperfect (unisexual) flowers that are usually borne in separate pistillate (female) and staminate (male) inflorescences on the same plant (monoecious) (Fig. 11). *Carex* and *Cymophyllus* are also unique among our sedges in having each pistillate flower enclosed within a small, sac-like perigynium (Fig. 11).

**Flowers.** The small flowers of many sedges are devoid of perianth segments (e.g., *Bulbostylis, Carex, Cymophyllus, Cyperus, Fimbristylis, Kyllinga*). However, others have a perianth of tiny bristles (Figs.12, 13) or hairs (Fig. 14). *Fuirena* has the most elaborate perianth, which is usually differentiated into two series—the outer three bristles and the inner three paddle-

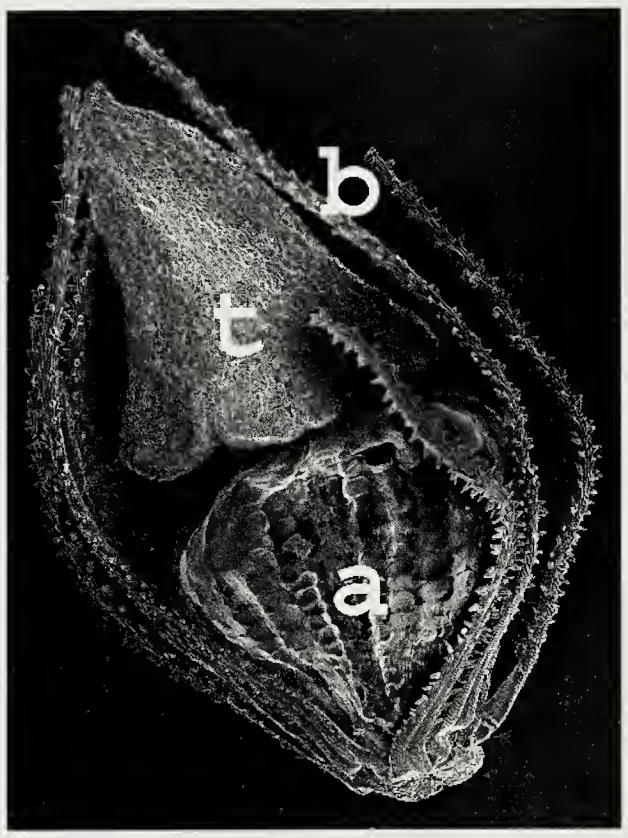


Figure 12. Scanning electron micrograph of achene-tubercle-perianth complex in *Eleocharis tuberculosa*. Note the tubercle (t) seated like a dunce-cap on the summit of the achene (a) and toothed perianth bristles (b) attached at the base of the achene.

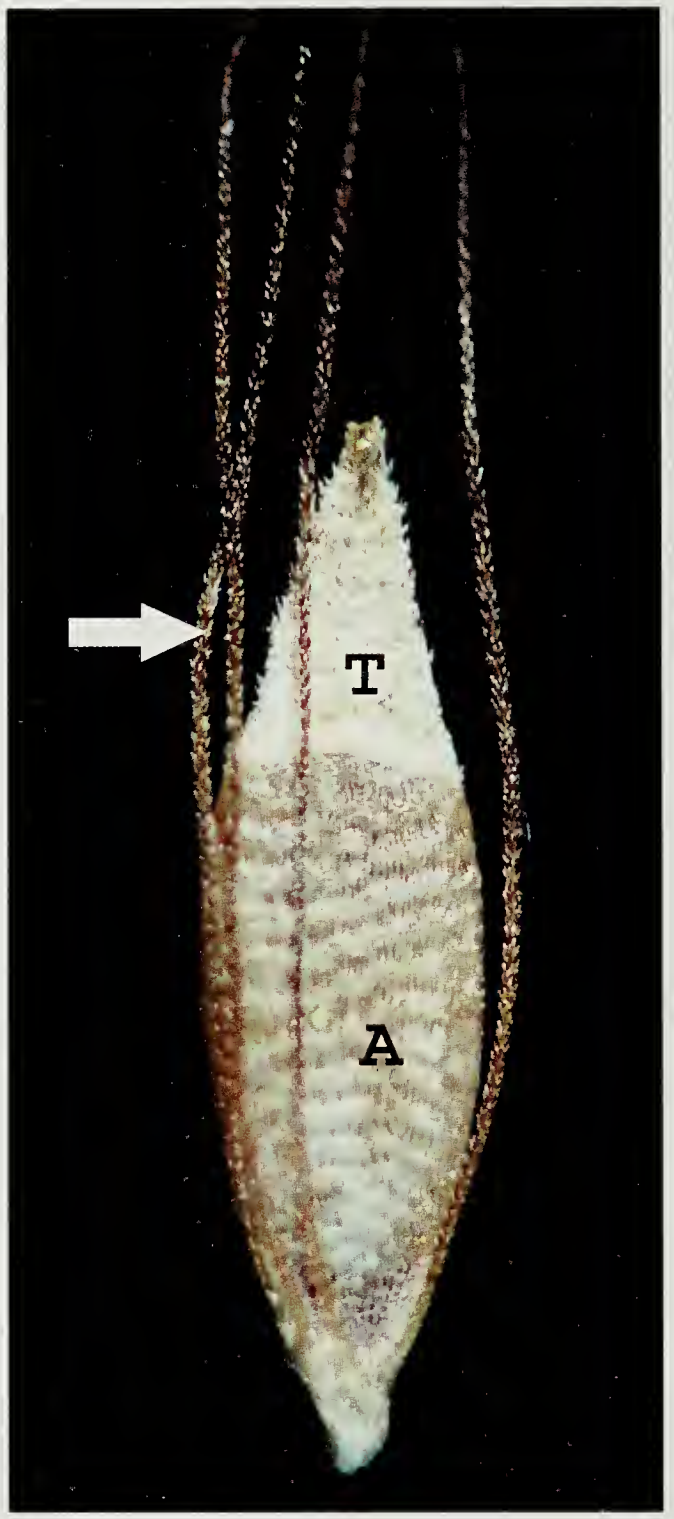


Figure 13. The achene-tubercle-perianth complex in *Rhynchospora inexpansa*. Note the whitish triangular tubercle (T) attached to the summit of the achene (A) and four toothed perianth bristles (arrow) attached at the base of the achene.

shaped segments (Fig. 15). When present, the perianth normally persists attached to the mature fruit (Figs. 12–15) and facilitates its dispersal. Perianth bristles generally have teeth along their edges that attach to fur or feathers of animals, and a perianth of long hairs undoubtedly promotes dispersal of the tiny fruits by wind. The numbers and kinds of perianth segments are useful in distinguishing among genera and species.

**Achenes and Associated Structures.** The small fruits of sedges, called achenes, have only one seed. Mature achenes are usually necessary for reliable identification. Achene shape is correlated with the number of carpels in the pistil. Pistils with two carpels normally have two-branched (bifid) styles and develop into biconvex (lenticular) or plano-convex achenes. Pistils derived from three carpels have three-branched (trifid) styles and form trigonous or terete achenes. The terete achenes of *Scleria* species are bony white (Fig. 16), and, in *Scleria* and other genera, the surface ornamentation of the achene is useful in distinguishing among species (Figs. 16–18). In *Fimbristylis,* the style is usually fringed with hairs (Figs. 19, 20), and, in a number of genera (e.g., *Bulbostylis, Eleocharis, Rhynchospora*), an enlarged style-base persists as a distinct tubercle (Figs. 12, 13, 21) attached to the summit of the achene. In *Scleria,* the achene usually has a rudimentary perianth adhering to its base in the form of a discoid or lobed hypogynium (Fig. 16).

## Generic Survey of the Sedges of Georgia

In the following survey, the genera are classified into groups that correspond more or less with tribes of the *Cyperaceae*. However, in electing

Figure 14. A portion of the overly mature inflorescence of *Scirpus cyperinus* showing scattered tiny, white achenes with persistent perianth. Note the entangled and dangling, curly perianth hairs.

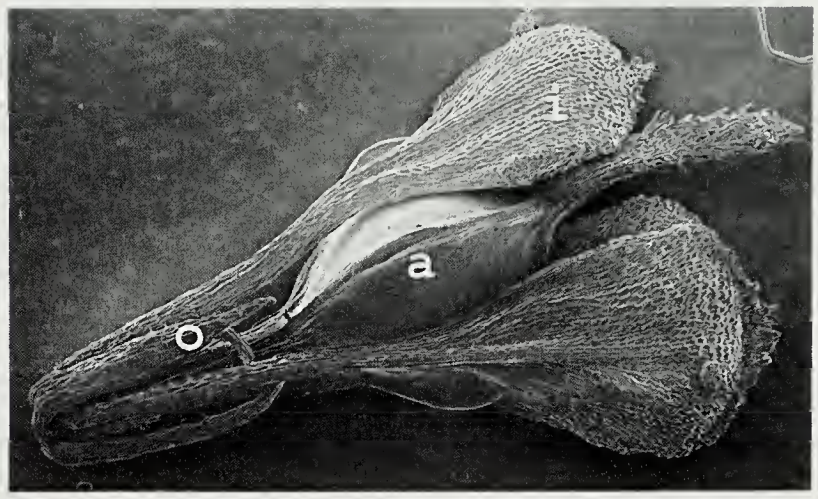


Figure 15. Scanning electron micrograph of achene-perianth complex in *Fuirena breviseta*. Note short, outer perianth segments (o); large, paddle-shaped, inner perianth segments (i); and the achene (a) with its stipitate base and its bristly, peg-like apex.

to emphasize form relationships instead of phylogeny, I have departed from recent tribal classifications[1, 16] in placing *Lipocarpha* and retaining the segregates of *Scirpus* in the same informal group with *Scirpus*. It is my belief that, in doing this, a more practical grouping of genera is achieved. English derivations of genus names are provided in order to make the Latin more approachable.[17, 18, 19]

Figure 16. The achene-hypogynium complex in *Scleria reticularis*; proximal (bottom) view on left showing three-lobed hypogynium and lateral/distal (top) view on right. Note reticulate-pitted achene surface and greenish hypogynium.

**The Spike-rush Sedge Group:** *plants apparently leafless, with bladeless leaves reduced to sheathing bases; inflorescence a single, terminal, unbranched spikelet; flowers perfect*

***Eleocharis*** (from Greek *elos*, marsh, and *charis*, grace)—**Spike-rushes**

The spike-rushes are the most structurally reduced sedges, consisting of little more than an apparently leafless stem terminated by an unbranched spikelet. However, the taxonomy of *Eleocharis* is complex, with marked variation in perianth, tubercles, and surface ornamentation of the achenes. *Eleocharis acicularis* (L.) R. & S., *E. microcarpa* Torr. and *E. parvula* (R.& S.) Link ex Bluff, Nees & Schauer are delicate plants with diminutive, cespitose habits; whereas others, such as *E. equisetoides* (Ell.) Torr. and *E. quadrangulata* (Michx.) R. & S., are graceful, stoloniferous perennials forming extensive stands sometimes dominating the shallows of ponds (Fig. 22). Tips of the arch-

Figure 17. The achene of *Scleria georgiana*. Note smooth, whitish, bony surface and absence of hypogynium in this species.

Figure 18. The spikelet of *Scleria reticularis* showing intact achene. Note three scales and reticulate-pitted surface of achene.

Figure 19. Achene with attached style in *Fimbristylis caroliniana* showing fringed, bifid style and two terminal stigmas.

Figure 20. Portion of inflorescence of *Fimbristylis puberula* showing spikelets with spirally arranged scales and fuzzy stigmas.

Figure 21. Achene of *Bulbostylis barbata* showing tubercle at upper right. Note transverse lines of cells on achene surface.

Figure 22. A stand of the graceful, emergent spikerush, *Eleocharis equisetoides*, in a shallow pond in Echols County, Georgia.

ing, aerial stems of *Eleocharis melanocarpa* Torr. and *E. baldwinii* (Torr.) Chapm. take root when they touch the ground, effecting a kind of "walking" asexual proliferation. Thusly, *E. baldwinii* forms dense mats on exposed hydric, sandy or peaty soils in flatwoods of the coastal plain.

A number of our species are adept colonizers following disturbance, especially in hydric soils of wetlands and floodplains and seasonally wet sites in fields and pastures, and some are listed as weeds, e.g., *E. obtusa* (Willd.) Schult., *E. montevidensis* Kunth and *E. quadrangulata.*[15] *Eleocharis albida* (Torr.) Torr. and *E. parvula* are particularly common and weedy in disturbed brackish soils along the Georgia coast, where they may be locally abundant.

***Websteria*** (commemorating G. W. Webster, American botanist and farmer, 1833–1914)

*Websteria* consists of a single species, *Websteria confervoides* (Poir.) Hooper, widely distributed in tropical, subtropical and warm temperate regions around the world.[20] In the United States, *Websteria* is infrequently collected and known only from Florida and Georgia, where it is found submersed in ponds and lakes.[20, 21] It has one-fruited spikelets and capillary stems and is vegetatively similar to and sometimes confused with *Eleocharis vivipara* Link.

**The Bulrush Sedge Group:** *plants usually leafy; scales spiral; flowers perfect; perianth of bristles or hairs, or absent; style base indistinct; tubercle absent*

*Scirpus* (classical Latin name for the bulrush)—**Bulrushes**

Traditionally, *Scirpus* has been defined broadly to encompass species more recently segregated into the genera *Bolboschoenus, Isol-*

Figure 23. The highly branched, compound inflorescence of *Scirpus cyperinus*. Note the individual spikelets with spirally arranged scales.

*epis, Oxycaryum* and *Schoenoplectus*.[22, 23, 24, 25] Although others[1, 16] have placed the *Scirpus* segregates variously, and sometimes questionably, in the tribes Cypereae, Fuireneae or Scirpeae, I have pragmatically grouped them with *Scirpus* (tribe Scirpeae), because all have spiral arrangement of scales, indistinct style bases, and etuberculate achenes.

*Scirpus* is characterized by leafy stems; a large, compound, cymose inflorescence of many spikelets; and glabrous scales with usually acute to acuminate tips. There are about eight species in Georgia, inhabiting a variety of hydric sites including floodplain forests, swamps, marshes, stream banks, wet meadows, and ditches.[22] *Scirpus divaricatus* Ell. haunts shaded floodplain forests and swamps, and *S. lineatus* Michx. and *S. pendulus* Muhl. are often associated with open, wet calcareous sites. *Scirpus cyperinus* (L.) Kunth, called wooly bulrush or wooly bully, is one of the most common and widespread bulrushes in Georgia (Fig. 23). This robust sedge has leaves with harsh, cutting edges and is sometimes a weed of disturbed, hydric sites, occurring in a variety of marshy and wetland habitats. The wooly perianth of *S. cyperinus* persists, attached to its tiny achene, and thus promotes wind dispersal (Fig. 14). Interestingly, two of the native *Scirpus* species occurring in Georgia are introduced in other parts of the world: *S. pendulus* in Australia and *S. georgianus* Harper in New Zealand.[22] Because of its epithet and the origin of its type in Clarke County, Georgia, *S. georgianus* deserves special note. It is widely distributed in the eastern United States and in Georgia is most common in the piedmont and mountain provinces. *Scirpus georgianus* has been treated as a variety[17] or synonym[21, 26] of *S. atrovirens* Willd. but more recently has been restored to the rank of species based upon its brownish scales and rudimentary or absent perianth.[22]

Figure 24. The pseudolateral inflorescence of nine sessile spikelets in *Schoenoplectus pungens*. The structure below the inflorescence is the stem. The paler greenish structure above is an erect, terminal leaf, not a continuation of the stem!

Figure 25. The dense carpet of green in this photograph is actually a floating mass of *Oxycaryum cubense* in an impounded bayswamp in Lowndes County, Georgia.

***Schoenoplectus*** (from Greek, *schoinos,* rush, and *plectos*, plaited, referring to use of stems in weaving of mats, etc.)—**Naked-stem Bulrushes**

The bulrushes with leafless, wand-like stems and ciliate scales are separated from *Scirpus* as *Schoenoplectus*, of which there are about ten species in Georgia.[24] *Schoenoplectus pungens* (Vahl) Palla, a common associate of the coastal salt-marsh community, is well marked by its pseudolateral clusters of sessile spikelets (Fig. 24) subtended by an erect bract that appears to be a continuation of the stem. *Schoenoplectus etuberculatus* (Steud.) Soják is found as an emergent in shallow ponds of the coastal plain or laxly submersed in swiftly flowing blackwater streams.

***Bolboschoenus*** (from Greek *bolbos,* bulb, and *schoinos,* rush, referring to the enlarged, cormous stem bases)—**Tuberous Bulrushes**

Bulrushes with leafy stems, cormous stem bases, large spikelets, and puberulent scales are included in *Bolboschoenus*. *Bolboschoenus robustus* (Pursh) Soják, seacoast bulrush, is the only well documented tuberous bulrush from Georgia.[23]

***Isolepis*** (from Greek, *isos,* equal, and *lepis,* scale, referring to the uniform floral scales)

*Isolepis* is a genus of mostly low, cespitose plants with basal leaves and terminal or pseudolateral capitate or solitary inflorescences. There are only two species of *Isolepis* in Georgia, both annuals. The native *Isolepis carinata* Hook. ex Arn. Ex Torr. [=*Scirpus koilolepis* Steud.] is an ephemeral inhabitant of intermittently wet depressions of fields and open woods during spring. *Isolepis pseudosetacea* (Dav.) Gand. [=*Scirpus molestus* M.C. Johnst.], an introduced species, has a similar habitat and phenology.[25]

***Oxycaryum*** (from Greek, *oxys,* sharp, and *carya,* nut, referring to the sharp-pointed achene)

The only species of the monotypic genus *Oxycaryum* is widespread in tropical, subtropical, and warm temperate regions of the Eastern and Western Hemispheres.[27] In the United States, *Oxycaryum cubense* (Poepp. & Kunth) Lye [=*Scirpus cubensis* Poepp. & Kunth] ranges from eastern Texas into Georgia and southward into peninsular Florida. It is apparently recently introduced into Georgia, first reported in 1996.[28] Spreading locally by stolons and forming extensive floating batteries in lakes, ponds, and wetlands (Fig. 25), this aquatic sedge could threaten freshwater aquatic communities in warmer parts of the southeastern

Figure 26. Subtended by leafy bracts, the terminal, capitate inflorescence of *Oxycaryum cubense* resembles *Kyllinga*.

Figure 27. Subtended by leafy bracts, the terminal, capitate inflorescence of *Lipocarpha maculata* resembles *Kyllinga*. Note the spiral scale arrangement of the spikelets.

United States. Its terminal, umbellate or monocephalous inflorescence subtended by whorls of leafy bracts gives *O. cubense* a superficial resemblance to some *Cyperus* and *Kyllinga* species (Fig. 26).

***Lipocarpha*** (from Greek *leipo*, to fall, and *carpha*, chaff, referring to the deciduous inner scales of certain species)

Georgia's only species, *Lipocarpha maculata* (Michx.) Torr., is somewhat ruderal. It is occasional to common in the coastal plain, where it is found in wet ditches, disturbed hydric soils of depressions in the flatwoods, and along the exposed margins of ponds. This species superficially resembles *Kyllinga* with its cespitose habit and terminal inflorescence of tightly clustered spikelets subtended by a whorl of leafy bracts (Fig. 27). The classification of *Lipocarpha* as more closely allied with either *Scirpus* (Tribe Scirpeae) or *Cyperus* (Tribe Cypereae) depends on how one interprets the various kinds of scales in the inflorescence and, thus, whether one views the inflorescence as a simple spikelet or a compound spike. Although the current, prevailing view is to interpret the inflorescence as a spike of reduced spikelets,[1, 16] I employ the simpler interpretation here and informally group *Lipocarpha* with *Scirpus* and other sedges with spikelets of spirally arranged scales and flowers, since this relationship of gross form is easier for non-specialists to see and grasp. This conundrum illustrates well the struggle inherent in two fundamental purposes of taxonomy to provide stable and ultimately useful means of identifying and naming plants and to construct classification schemes that reflect phylogenetic (evolutionary) relationships.

**The Umbrella-grass Sedge Group:** *plants mostly leafy; leaf blades or sheaths usually pubescent; scales spiral, usually pubescent; flowers perfect; perianth differentiated into two series, 3 outer bristles and 3 inner paddle-like segments; achene with stipitate base and peg-like apex; tubercle absent*

***Fuirena*** (commemorating Georg Fuiren, Danish Botanist, 1581–1628)—**Umbrella-grasses**

Five species of *Fuirena* are known to occur in Georgia: *Fuirena breviseta* (Cov.) Cov., *F. longa* Chapm., *F. pumila* (Torr.) Spreng., *F. scirpoidea* Michx., and *F. squarrosa* Michx. All are heliophytes of wetland habitats, including bogs, marshes, interdunal swales, ditches, margins of ponds, and wet depressions in savannas[29, 30] Robert Kral's[29] thorough treatment of *Fuirena* for North America provides a dichotomous key for identification, technical descriptions, distribution maps, and illustrations. The umbrella-grasses are well marked by their usually leafy

Figure 28. A portion of the inflorescence of *Fuirena breviseta* showing large spikelets with spiral scales and pubescent bract.

Figure 29. The terminal, head-like cluster of spikelets with reddish brown scales in *Bulbostylis barbata.*

stems; pubescent leaves; large spikes; spirally arranged scales; perianth in two distinct series; and distinctive achene with stipitate base and peg-like apex (Figs. 15, 28). Although most species have conspicuously leafy stems, the coastal species *F. scirpoidea* and *F. longa* have reduced leaf blades and a wand-like habit, unusual in *Fuirena.*

**The Fringe-sedge Group:** *plants leafy; leaves basal; inflorescences terminal; scales spiral; flowers perfect; perianth absent; style-base distinct; tubercle present* (Bulbostylis) *or absent* (Fimbristylis) ***Fimbristylis*** (from Latin *fimbria*, fringed, and *stylus*, style)—**Fringe-sedges**

*Fimbristylis* and *Bulbostylis* are distributed mostly in tropical and warm temperate regions around the world, and Kral's[31] thorough account of the North American species of these genera provides a dichotomous key for identification, technical descriptions, distribution maps, and illustrations. As the genus name suggests, most *Fimbristylis* species have a fringed style with its base clearly distinct from the summit of the attached achene (Figs. 19, 20). Our species include a number of weeds widely distributed in both the Old and New Worlds: *Fimbristylis schoenoides* (Retz.) Vahl, *F. tomentosa* Vahl, *F. dichotoma* (L.) Vahl, *F. annua* (All.) R. & S., and *F. miliacea. Fimbristylis annua, F. dichotoma, F. miliacea,* and *F. tomentosa* have long been associated with rice agriculture and were probably brought into the southeastern United States from Asia as contaminants of rice seed shortly after colonization by Europeans.[31, 32] Most *Fimbristylis* species have branched, umbellate inflorescences of several to many spikelets. However, in *F. schoenoides* the inflorescence is usually reduced to a single spikelet, imparting an *Eleocharis* look to the plants until a closer inspection of the tufted stems reveals narrow basal leaves.

*Fimbristylis perpusilla* Harper was first collected by Roland M. Harper from Sumter County, Georgia[33] and is endangered in Georgia.[34] This diminutive sedge is endemic to the southeastern United States, where it occurs sporadically along the exposed shores of ponds and reservoirs from Georgia to Delaware and is sometimes locally abundant.[31, 32, 35] Robert Kral's long-term observations, suggesting sporadic occurrences of this species, are of interest.[35] In 1962, he noted that *F. perpusilla* was locally abundant but apparently restricted to only one pond in Seminole County, Georgia, despite there being other similar ponds in the area. He also observed only a few plants upon revisiting the site a year later and a great abundance again ten years later! *Fimbristylis brevivaginata* Kral, described as a new species in

Figure 30. Cespitose habit of the annual weed *Cyperus difformis* in McIntosh County, Georgia.

1992 and narrowly endemic on granitic and sandstone outcrops in the Cumberland Plateau of Alabama and the Piedmont of Georgia, is of possible conservation concern.[32, 36]

***Bulbostylis*** (from Latin *bulbus*, bulbous, and *stylus*, style, referring to the enlarged bulbous style bases of many species)

As the genus name suggests, in most *Bulbostylis* species the swollen base of the style forms a distinct tubercle on the summit of the achene (Fig. 21). *Bulbostylis barbata* (Rottb.) C. B. Clarke is widely distributed in both Old and New Worlds.[31, 37] With its reddish-brown inflorescences (Fig. 29), this diminutive sedge is often locally abundant and conspicuous en masse in the coastal plain during late summer and autumn especially in open, disturbed, sandy areas and along the edges of agricultural fields. *Bulbostylis warei* (Torrey) C. B. Clarke, endemic to the Atlantic and Gulf coastal plain of the southeastern United States, inhabits open sands in longleaf pine-scrub oak communities; this tufted perennial has hemispherical, head-like clusters of spikelets and distinctive inflorescence bracts with beautifully fringed basal sheaths.

**The Flat-sedge Group:** *plants leafy; leaves basal; leafy bracts subtending inflorescence; inflorescence terminal, umbellate with pedunculate rays or capitate cluster of sessile spikes; scales distichous; flowers perfect; perianth absent; style base indistinct; tubercle absent*

***Cyperus*** (from Greek *cyperus*, edge, referring to the sharp-edged leaves or perhaps the three-edged stems)—**Flat-sedges or Umbrella Sedges**

*Cyperus* is distinguished by spikelets with distichous (two-ranked) floral scales, usually two

or more flowers and fruits per spikelet, and the absence of a perianth. Some *Cyperus* species (e.g., *C. flavescens* L., *C. polystachyos* Rottb., *C. sanguinolentus* Vahl) have pistils with two stigmas and lenticular achenes. Others have pistils with three stigmas and trigonous achenes. *Cyperus* species also differ in how the spikelets, scales and achenes separate from the inflorescence at maturity. In *C. odoratus* L., the spikelets break apart into one-fruited segments (Fig. 10). In other species, like *C. flavescens, C. polystachyos,* and *C. haspan* L., the achenes and scales fall away one by one from the base to the apex of the spikelet axis (Fig. 8), and in another group that includes *C. croceus* Vahl, *C. echinatus* (L.) Wood, *C. retrorsus* Chapm., and *C. strigosus* L. the entire spikelet drops off intact—achenes, scales and all (Fig. 9).

*Cyperus species are among the world's most notorious weeds, and some of the diverse characteristics and strategies that make plants competitive weeds are illustrated well by these sedges.*

In Georgia, *Cyperus* species are found in diverse habitats. Some, like *Cyperus distinctus* Steud., *C. erythrorhizos* Muhl., *C. flavescens, C. haspan, C. lanceolatus* Poir., *C. odoratus, C. ovatus* Baldw., *C. polystachyos, C. pseudovegetus* Steud., *C. strigosus,* and *C. surinamensis* Rottb., and *C. virens* Michx., inhabit open, hydric soils along stream banks or shores of ponds and lakes or in ditches. Other species, like *C. filiculmis* Vahl, *C. grayii* Torr., *C. hystricinus* Fern., *C. plukenetii* Fern. and *C. nashii* Britt. ex Small, tend toward more xeric sites and are often associates of longleaf pine-scrub oak communities in the coastal plain. *Cyperus croceus, C. retrorsus* and *C. echinatus* are occasional to common in well drained soils, along roadsides or in poorly kept lawns or other disturbed sites. *Cyperus tetragonus* Ell. is endemic to the coastal plain of the southeastern United States (Florida, Georgia, South Carolina), and in Georgia it is found on well drained, sandy soils in the maritime live oak forest on barrier islands or the immediately adjacent mainland. *Cyperus granitophilus* McVaugh is endemic to granitic and sandstone outcrops in the piedmont of Georgia and adjacent states.

*Cyperus* species are among the world's most notorious weeds, and some of the diverse characteristics and strategies that make plants competitive weeds are illustrated well by these sedges. *Cyperus rotundus* (purple nut-sedge) and *C. esculentus* (yellow nut-sedge), the world's *worst* and *sixteenth worst* weeds, respectively, are distributed around the world in tropical, subtropical, and warm-temperate regions.[14] Their common names derive from the colors of their floral scales. Although both species are major agricultural, lawn, and garden pests in Georgia, they infrequently set viable seeds. Instead their reproduction and dispersal is primarily asexual, through tubers formed at the tips of rhizomes.[38] In contrast with the sweet, edible tubers (*chufas*) of yellow nut-sedge, those of purple nut-sedge are bitter and inedible.[38, 39] Although reproduction and dispersal in these sedges is mostly asexual, they rarely reproduce sexually, forming small achenes that are readily dispersed. This combination of asexual and sexual reproduction, has enabled purple and yellow nut-sedge to be among the world's most successful weeds and to colonize agricultural areas throughout much of the world.

The annual sedges *Cyperus difformis* and *C. iria*, also among the world's worst pests, have evolved a very different strategy, in which individual plants produce tremendous numbers of tiny, readily dispersed achenes and have very short life cycles. A single plant of *C. iria* can produce more than 5,000 viable seeds, and an individual of *C. difformis* can set 50,000 seeds.[14] *Cyperus difformis* and *C. iria* can produce multiple generations each growing season, with *C. difformis* completing its life cycle in only four to six weeks.[14] In the southeastern

Figure 31. The terminal, capitate inflorescence of *Kyllinga odorata*. Note the yellow anthers extending from white scales of spikelets.

Figure 32. The solitary, terminal spike of *Kyllinga squamulata* in Lowndes County, Georgia.

United States, *C. difformis* (Fig. 5, 30) and *C. iria* are primarily weeds of ditches, rice fields, and poorly drained sites in other agricultural fields or disturbed areas. *Cyperus iria* is common and widespread throughout much of the state. *Cyperus difformis* was first reported from Georgia in Lanier County in 1996[28] and has been found more recently in McIntosh County.[40] Despite its tremendous reproductive potential, *C. difformis* does not yet appear to be widespread or common in Georgia.

*Cyperus entrerianus* Boeck. (deeprooted sedge) is native to temperate regions of South America and was first reported from the United States in 1990.[41] It ranges from eastern Texas into Georgia and Florida in the southeastern United States, where flooding, construction equipment, mowing, and soil moving activities, especially along highways, disperse its small achenes.[41, 42] An individual plant of deeprooted sedge can set more than 100,000 achenes per year,[42, 43] and, in addition to producing tremendous numbers of seeds, it is a perennial with short, deeply set rhizomes and corms that persist through the winter. Thus, *Cyperus entrerianus* will likely continue to spread in the coastal plain of Georgia, where it occupies ditches and other low, disturbed sites in the flatwoods.

*Kyllinga* (commemorating Peter Kylling, seventeenth century Danish botanist)—**Green Sedges**

*Kyllinga* is distinguished by its terminal, capitate inflorescence (Fig. 31, 32); two-scaled, one-fruited spikelets (Fig. 33, 34); and lenticular achenes. The roots of fresh *Kyllinga* plants have a characteristically pleasant fragrance. *Kyllinga* is closely related to and probably derived from *Cyperus*, and some modern authors treat it within *Cyperus* as a subgenus or section.[21, 27, 44] Five species of *Kyllinga* are known to occur in Georgia, including *K. squamulata* Thonn. ex Vahl not previously reported from the state. *Kyllinga brevifolia* Rottb. and *K. gracillima* Miq. are rhizomatous perennials, and *K. odorata* Vahl and *K. pumila* Michx. are cespitose annuals or short-lived perennials.

*Kyllinga pumila* was initially described by Michaux[45] in the first North American flora and is evidently our only native *Kyllinga* species. The naturalized species *K. brevifolia* and *K. odorata* were introduced long ago, with *K.*

Figure 33. Spikelets of *Kyllinga odorata* with backlighting to show single brownish achene enclasped by paired translucent floral scales.

Figure 34. The spikelet of *Kyllinga squamulata* consists of two scales enclasping a single achene. Note distinct tips and lacerate keels of paired scales.

*brevifolia* being reported initially in the United States in 1821 by Stephen Elliott[46] and *K. odorata* in 1836 by John Torrey.[47] Bryson et al.[48] provide an illustrated account of *Kyllinga* species present in the southeastern United States, all of which can be weeds of lawns or turf-grass. Although previously known in the United States only from Florida and South Carolina,[48] *Kyllinga squamulata* (Figs. 32, 34) has been found recently as a weed in turf-grass on athletic fields in Lowndes and Chatham counties, Georgia.[40]

Figure 35. The upper portion of the culm of *Dulichium arundinaceum* showing lanceolate leaf blades and axillary inflorescences.

**The Three-Way Sedge Group:** *plants leafy; stem terete; leaves cauline; upper leaves with well-developed lanceolate blades, conspicuously three-ranked; inflorescences axillary; scales distichous; flowers perfect; perianth of 6–9 bristles*

***Dulichium*** (Latin name for a kind of sedge)—**Three-way Sedge**

The only species in this distinctive, monotypic genus is *Dulichium arundinaceum.* The following combination of characteristics makes even sterile plants easy to identify: rhizomes; terete stems; well developed and conspicuously three-ranked, cauline leaves; and axillary inflorescences (Fig. 35). Also, the combination of perianth bristles and distichous scales is found elsewhere among Georgia sedges only in *Eleocharis baldwinii* and *Websteria confervoides.* The descriptive common name, three-way sedge, is derived from the delightfully tristichous (three-ranked) leaves, best observed in

Figure 36. A sterile culm of *Dulichium arundinaceum*, three-way sedge, looking from tip toward base of stem, showing tristichous (three-ranked) leaves.

Figure 37. A globose, axillary spike of *Rhynchospora cephalantha* Gray showing bract with sheathing base.

the field by looking straight down the stem (Fig. 36). In Georgia, the three-way sedge is found in acidic soils of depressions along blackwater streams and shallows along ponds associated with such streams.

THE BEAK-RUSH SEDGE GROUP: *plants leafy; scales spiral; flowers perfect; perianth of few to many bristles or absent in sections* Dichromena *and* Psilocarya; *stigmas 2 (–3); achene biconvex to subterete; tubercle present*

***Rhynchospora*** (from Greek *rhyncho*, snout or beak, and *spora*, seed, referring to the beaked achenes of many species)—**Beak-rushes** *Rhynchospora* is a taxonomically complex genus, well represented in the coastal plain of the southeastern United States, where remarkable numbers of beak-rush species can occur together in bogs, seeps, or wet savannas (Fig. 37). Although most beak-rushes inhabit hydric soils in bogs, wet savannas, margins of ponds, seeps, and depressions in flatwoods, *R. megalocarpa* Gray and *R. grayi* Kunth are found in open, xeric, sandy pinelands or sandscrub.

Species that are opportunistic colonizers of pastures, lawns, pond margins, and ditches, are treated as weeds, and one of our natives, *Rhynchospora caduca* Ell., is recently naturalized and spreading rapidly in Hawaii,[49, 50] suggesting other native beak-rushes could be invasive if introduced to other parts of the world. Although none is officially protected, a number of Georgia beak-rushes are of conservation concern: *R. crinipes* Gale, found on banks and bars of blackwater streams; *R. harveyi* var. *culixa* (Gale) Kral, found in ecotones between sandhills and bogs; *R. solitaria* Harper, inhabiting hillside bogs; and *R. thornei* Kral, growing along margins of limesink ponds.[35, 51, 52]

Historically, species with conspicuous, green-tipped, white bracts have been treated in the segregate genus *Dichromena*; however, a compelling case has been made for including these white-topped sedges in *Rhynchospora*.[53] These are striking plants in the field (Fig. 1), and two species are found in Georgia: *R. colorata* (L.) Pfeiff., an inhabitant of basic or circumneutral soils in seeps or swales, and *R. latifolia* (Baldw.) Thomas, a more robust plant of acidic soils of bogs and wet savannas. *Psilocarya,* formerly a small genus of annuals lacking perianth bristles, is also now treated within *Rhynchospora*.[52]

THE SAWGRASS SEDGE GROUP: *plants leafy; scales spiral; flowers perfect; perianth absent; stigmas 3; achene terete*

*Cladium* (from Greek *clados*, branch, alluding to the branched inflorescence)—**Sawgrass**

There are two species of *Cladium* in the southeastern United States: *C. jamaicense* Crantz and *C. mariscoides* (Muhl.) Torrey. Only *Cladium jamaicense*, sawgrass, is known to oc-

cur in Georgia. The predominant species of the Everglades marshes of southern Florida, this robust perennial with graceful, delicate inflorescences and lacerating foliage inhabits brackish and freshwater marshes along the Georgia coast and occasionally inland.[21]

**The Nut-rush Sedge Group:** *plants leafy; flowers imperfect; spikelet generally with pistillate flowers below staminate and with several empty basal scales; achenes whitish, bony; hypogynium usually present*

***Scleria*** (from Greek *scleros*, hard, referring to the bony achene)—**Nut-rushes**

In *Scleria,* the spikelets generally have both pistillate and staminate flowers with pistillate flowers below the staminate and several empty scales below the pistillate flowers at the base of the spikelet. The whitish, bony surfaces of the achenes are variously smooth, pitted, reticulate or pubescent (Figs. 16–18), and fused to the base of the achene there is usually a discoid, tuberculate, or lobed structure called the hypogynium (Fig. 16). There are about twelve species of *Scleria* in Georgia. Although most of our species (e.g., *S. baldwinii* (Torr.) Steud., *S. georgiana* Core, *S. minor* (Britt.) Stone, *S. muehlenbergii* Steud., *S. reticularis* Michx., *S. verticillata* Muhl. ex Willd.) are found on fairly wet sites such as open, moist, sandy or peaty soils of seepage slopes, bogs, depressions in flatwoods, and pond margins, *S. triglomerata* Michx. and *S. oligantha* Michx. are more often found on mesic to subxeric sites in shaded woods, open prairies, and pineland savannas. *Scleria ciliata* Michx. and *S. pauciflora* Muhl. ex Willd. both exhibit ample variation with several named varieties each and substantial ranges in habitat from dry to hydric sites.[54]

**The Caric Sedge Group:** *plants leafy; flowers imperfect; staminate (male) and pistillate (female) flowers often borne in separate inflorescences or one type above the other in the same inflorescence; sac-like perigynium enclosing each pistillate flower and achene*

***Carex*** (from Greek *cairo*, to cut, referring to sharp edges of leaves in certain species)—**Caric Sedges**

Figure 38. A portion of the leaf of *Cymophyllus fraserianus* showing finely toothed margin and absence of midrib.

*Carex* is well marked by imperfect flowers and, its most distinctive feature, the perigynium enveloping each pistillate flower and fruit (Fig. 11). Most *Carex* species occur in the northern temperate zone where they are primarily found in mesic, woodland habitats. With more than 2000 species, *Carex* is the largest genus of Cyperaceae and one of the largest genera of the world's flora. *Carex* is also the largest genus of plants in Georgia and includes a number of recently named species found in the state: *Carex acidicola* Naczi, described in 2002; *C. appalachica* Webber & Ball, 1979; *C. calcifugens* Naczi, 2002; *C. cumberlandensis* Naczi, Kral & Bryson, 2001; *C. gholsonii* Naczi & Cochrane, 2002; *C. godfreyi* Naczi, 1993; *C. kraliana* Naczi & Bryson, 2002; *C. manhartii* Bryson, 1985; *C. pigra* Naczi, 1997; *C. planispicata* Naczi, 1999; *C. superata* Naczi, Reznicek & Ford, 1998; and *C. thornei* Naczi, 2002. Of these, *Carex acidicola, C. calcifugens* and *C. thornei* are of possible conservation concern.[19]

Figure 39. *Cymophyllus fraserianus* at author's left. Photograph by Sharon Carter

The majority of Georgia's officially listed rare and protected sedges are *Carex* species.[34] *Carex baltzellii* Chapm. ex Dewey, endangered in Georgia, is a rare plant of beech-magnolia forests on steep slopes of ravines, ranging from southern Mississippi to southwestern Georgia and northern Florida.[35] Other rare caric sedges with official legal status in Georgia as threatened species are Biltmore sedge, *Carex biltmoreana* Mack., restricted to steep, sunny, granitic seeps in the Blue Ridge Province of northeastern Georgia, South Carolina and North Carolina;[35] *Carex manhartii* Bryson, a denizen of moist deciduous or mixed deciduous evergreen forests in the Appalachians from West Virginia southward to northern Georgia;[55] wretched sedge, *Carex misera* Buckley, whose leaves droop forlornly from shaded granitic cliffs and balds in the Blue Ridge from northeastern Georgia, eastern Tennessee and western North Carolina;[35, 56] and *Carex purpurifera* Mack., found in rocky, moist, deciduous forests in the southern Appalachians, usually associated with limestone.[35, 55] *Carex dasycarpa* Muhl., an inhabitant of sandy, hardwood forests and hammocks in the coastal plain from Mississippi to South Carolina, has rare status in Georgia and is considered to be rare elsewhere in its range.[57]

***Cymophyllus*** (from Greek *kyma*, wave, and *phyll*, leaf, referring to wavy leaf margins)

The monotypic genus *Cymophyllus* differs from *Carex* primarily in having a single (rarely two) basal leaf. Its evergreen leaf has a broad flattened blade with finely toothed margins and lacks a midrib (Figs. 38, 39). The only species, Fraser's sedge, *Cymophyllus fraserianus* (Ker-Gawl.) Kartesz & Gandhi, inhabits rocky, mesic woods in the Appalachians from West Virginia into northeastern Georgia.[35, 58] Plants have striking white inflorescences and are probably pollinated by insects.[59] Fraser's sedge has threatened status in Georgia[34] and is sometimes cultivated as an ornamental in woodland gardens. [9, 60]

## Dichotomous Key to the Sedge Genera of Georgia

1a. Achenes enclosed within a loosely or tightly fitting sac-like perigynium . . . . . 2

1b. Achenes not enclosed within sac-like perigynium . . . . . 3

2a. Basal leaves more than 2; leaf blades folded with keeled midrib and basal sheath . . . . . *Carex*

2b. Basal leaves 1(-2); leaf blades flattened without midrib or sheath . . . . . *Cymophyllus*

3a. Leaves bladeless, reduced to sheaths, thus plants appearing essentially leafless; culm terminated by a single, unbranched spikelet. . . . . *Eleocharis*

3b. Plants usually with some bladed leaves evident; culm usually terminated by a compound inflorescence of multiple spikelets variously arranged. . . . . 4

4a. Scales two-ranked (distichous) . . . . . 5

4b. Scales spirally arranged . . . . . 7

5a. Leaves cauline; stems terete; perianth present . . . . . *Dulichium*

5b. Leaves basal; stems mostly trigonous; perianth absent. . . . . 6

6a. Spikelets usually with more than two scales and two or more achenes; inflorescence usually with pedunculate rays. . . . . *Cyperus*

6b. Spikelets with two scales and one achene; inflorescence a terminal cluster of one to several sessile heads. . . . . *Kyllinga*

7a. Style-base persistent, forming distinct tubercle atop achene . . . . . 8

7b. Style base not persistent, tubercle absent . . . . . 9

8a. Sheath summit or juncture of blade and sheath with tufts of lines of hairs; perianth absent; tubercle forming small bulbous structure atop achene . . . . . *Bulbostylis*

8b. Sheath summit and juncture of blade and sheath glabrous; perianth bristles present or absent; tubercle usually larger, conicle, subulate, or otherwise shaped, rarely small and bulbous . . . . . *Rhynchospora*

9a. Perianth absent or present as a single series of bristles or hairs. . . . . 10

9b. Perianth in two series, differentiated into three outer stout bristles and three inner bladed and paddle-like segments . . . . . *Fuirena*

10a. Leaves cauline. . . . . 11

10b. Leaves entirely basal, or mostly basal with only 1 (-2) cauline leaves, or reduced to inconspicuous rudimentary blades . . . . . 13

11a Achene subterete . . . . . *Cladium*

11b. Achenes trigonous, biconvex or plano-convex. . . . . 12

12a. Spikelets mostly less than 3.5 (-5) mm in diameter; scale glabrous, apex rounded to acute; culms without cormous bases; achene minutely papillose. . . . . *Scirpus*

12b. Spikelets mostly more than 4 mm in diameter; scale pubescent, apex notched and awned; culms with cormous bases; achene smooth . . . . . *Bolboschoenus*

13a. Style base markedly distinct from achene summit; style usually fringed with hairs . . . . . *Fimbristylis*

13b. Style base not distinct from achene summit; style not fringed. . . . . 14

14a. Infloresence bracts usually conspicuous and leaf-like, mostly spreading to divaricate and exceeding the inflorescence . . . . . 15

14b. Inflorescence bracts inconspicuous or few with at most only the lowest exceeding the inflorescence, sometimes largest bract appearing as continuation of the stem . . . . . 16

15a. Cespitose annual; achene trigonous or terete . . . . . *Lipocarpha*

15b. Stoloniferous perennial; achene plano-convex with corky margins and apex . . . . . *Oxycaryum*

16a. Achene rugose (sometimes faintly so), transversely ridged or smooth . . . . . *Schoenoplectus*

16b. Achene papillose. . . . . *Isolepis*

## Glossary [61, 62, 63]

**Achene**—a small, single-seeded, dry fruit

**Acuminate**—abruptly narrowing to a sharp-pointed apex

**Acute**—gradually and consistently narrowing to a sharp-pointed apex

**Annual**—a plant that persists for no more than one year, going from seed to seed within a period of one year or less

**Apex**—the summit or tip of a structure

**Asexual reproduction**—reproduction without sexual union of gametes; usually involving growth from a vegetative organ such as a rhizome, stolon, corm or bulb

**Axil**—the angle formed by leaf and stem at the node

**Axillary**—developing from and attached at the leaf axil

**Basal**—developing from and attached to the base of the plant or structure

**Biconvex**—a structure such as an achene with two convex faces and two edges

**Bifid**—with two branches

**Bisexual**—having both male (stamen) and female (pistil) parts; usually with reference to the flower

**Blade**—the expanded, flattened portion of the leaf arising from the rim of the sheath

**Bract**—a modified leaf positioned below a flower or an inflorescence

**Bulbous**—bulb-shaped

**Capillary**—a slender, hair-like structure

**Capitate**—compact and head-like

**Carpel**—the fundamental unit of the pistil bearing the immature seeds (ovules) of the flowering plant; thought to be a highly modified leaf

**Cauline**—of or on the stem; cauline leaves are stem leaves, as opposed to basal leaves

**Cespitose**—with the stems basally clumped or tufted

**Compound**—branched

**Conical**—cone-shaped

**Corm**—a modified stem, usually subterranean, usually broader than high, with a series of ring-like nodes and internodes; its functions include asexual reproduction and food storage

**Cormous**—corm-shaped or bearing corms

**Culm**—the stem of a grass or sedge

**Cyme**—a compound inflorescence based upon sets of three flowers each, with the central, sessile flower developing first

**Cymose**—an inflorescence of cymes or one resembling cymes; in context of sedges, an inflorescence with spikelets in branched sets of three, the central spikelet being sessile and the two lateral ones pedunculate

**Dioecious**—with male (staminate) and female (pistillate) flowers on separate plants; opposite of monoecious

**Discoid**—disc-shaped

**Distichous**—in two ranks; two-ranked

**Divaricate**—spreading at a wide angle

**e**—prefix meaning without; for example, *etuberculate* "without a tubercle"

**Erect**—vertical

**Fimbriate**—fringed

**Glabrous**—smooth; without pubescence

**Habit**—general appearance, posture, and manner of growth; for example, annual herb, shrub, tree, vine

**Habitat**—where the organism grows

**Head**—a very compact, tight inflorescence

**Hydric**—wet; usually descriptive of a habitat or soil; see *mesic, xeric*

**Hypogynium**—the lobed or discoid structure fused with the base of the achene in *Scleria* (Fig. 16)

**Imperfect**—unisexual flowers having either male (stamen) or female (pistil) parts

**Inflorescence**—a group or cluster of flowers

**Keel**—a structure shaped like a boat's keel

**Keeled**—like a keel or with a keel

**Lanceolate**—lance-shaped

**Lateral**—developing and attached along the sides of the stem

**Lenticular**—lens-shaped; compressed and two-angled in cross section

**Linear**—long and narrow with more or less parallel sides

**Mesic**—moderately moist; usually descriptive of a habitat or soil; see *hydric, xeric*

**Monoecious**—having both staminate and pistillate flowers on the same plant; opposite of dioecious

**Monocephalous**—having one head

**Monotypic**—a taxonomic group with only one representative; for example, a genus with only one species

**Panicle**—a highly branched inflorescence, with the branches usually alternately arranged

**Paniculate**—having a panicle or like a panicle

**Papillose**—covered with tiny, pimple-like protuberances

**Peduncle**—a stalk-like stem bearing an inflorescence

**Pedunculate**—with peduncles

**Perennial**—a plant that persists for more than two years

**Perfect**—a flower with both male (stamen) and female (pistil) parts

**Perianth**—the outer series of floral parts peripheral to the stamens and the pistil; in the typical flower, the perianth consists of sepals and petals collectively; in sedges the perianth segments, when present, are reduced to bristles, hairs, scales, or similar structures

**Perigynium** (perigynia, plural)—a sac-like structure enveloping the pistillate flower and achene in species of *Carex* and *Cymophyllus*

**Pistil**—the "female" floral structure composed of basal ovary; slender, neck-like style; and terminal stigma

**Pistillate**—having one or more pistils but lacking a stamen; referring to the unisexual "female" flower or the inflorescence or plant

**Pitted**—covered with tiny depressions

**Plano-convex**—a structure with two faces and two angles, with one face flattened and the other curved (convex)

**Pseudolateral**—appearing to be lateral, but actually terminal

**Puberulent**—minutely pubescent

**Pubescent**—covered with hairs

**Ray**—a major branch of an inflorescence

**Reticulate**—netted

**Rhizomatous**—producing or having a rhizome

**Rhizome**—elongated, horizontal, subterranean stem with nodes, buds and scale-like leaves

**Rugose**—with a wrinkled surface

**Scale**—a small bract associated with the flowers of sedges

**Sessile**—without a stalk

**Sheath**—the modified base of the sedge leaf enveloping the stem

**Simple**—unbranched

**Solitary**—borne singly

**sp.**—an abbreviation for *species* (singular), often used after the genus name to denote a single species not specifically named

**spp.**—an abbreviation for *species* (plural), often used after the genus name to denote multiple species not specifically named

**Spicate**—in the form of a spike or like a spike

**Spike**—a simple, indeterminate inflorescence with sessile flowers

**Spikelet**—the fundamental unit of the sedge inflorescence; a small spike with highly reduced, sessile flowers, each normally subtended by a scale

**Spreading**—outstretched

**Stamen**—the "male" floral structure consisting of slender, supporting filament and terminal anther, with pollen produced in the anther

**Staminate**—having one or more stamens but lacking a pistil; referring to the unisexual "male" flower or the inflorescence or plant

**Sterile**—lacking functional sexual organs

**Stigma**—the terminal portion of the pistil, which is receptive to pollen

**Stipitate**—with a stalked base

**Stolon**—elongated, horizontal stems arising from the plant base, usually growing at or just below the soil surface

**Stoloniferous**—bearing stolons or having a stolon

**Style**—the slender, neck-like portion of the pistil above its basal ovary; sometimes with branches

**Subulate**—awl-shaped; a stiffish structure that tapers from base to apex

**Subterete**—almost circular in cross-section; see *terete*

**Subxeric**—somewhat xeric; transitional from xeric to mesic; see *mesic, xeric*

**Terete**—round in cross-section

**Terminal**—developing and attached at the tip of the stem

**Trifid**—with three branches

**Trigonous**—three-angled

**Tristichous**—in three ranks; three-ranked

**Tuber**—a thickened subterranean stem, usually developing at the apex of a rhizome

**Tubercle**—an enlarged style base that persists attached to the summit of the mature achene; characteristic of certain species of *Bulbostylis, Eleocharis, Rhynchospora*

**Umbel**—a simple inflorescence with many well developed pedicels all arising from near the same point at the distil end of the peduncle; inflorescence spherical, or with a convex or flat top

**Umbellate**—in the form of an umbel; descriptive of the inflorescences of many *Cyperus* spp.

**Unisexual**—having either male (stamen) or female (pistil) parts, but never both; usually with reference to the flower

**Voucher**—a dried plant specimen with collection data on its label, preserved in an herbarium as a permanent record documenting the occurrence of a species at a particular geographical location

**Xeric**—dry; usually with reference to a habitat or soil; see *hydric, mesic*

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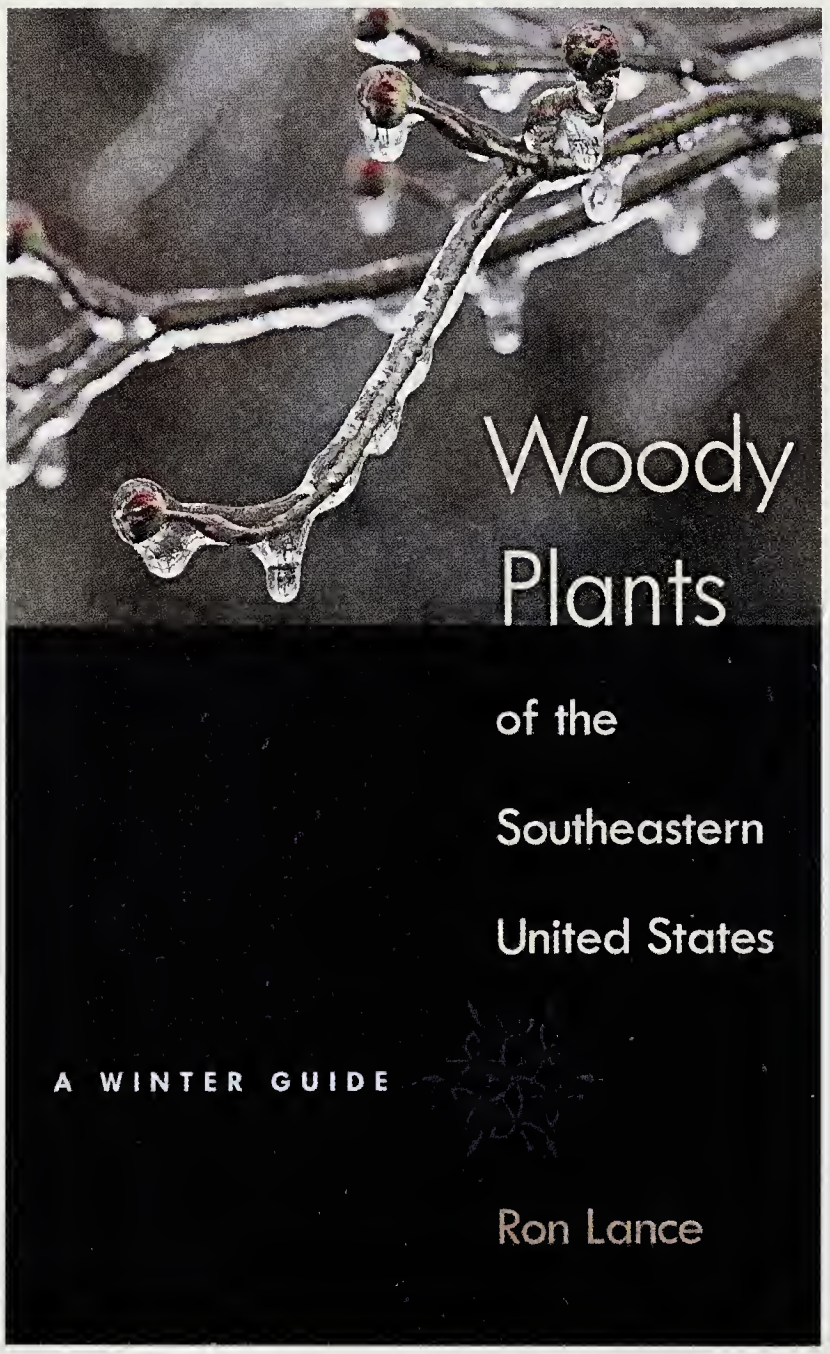
# Book Review

## Woody Plants of the Southeastern United States, *A Winter Guide*

by Ron Lance




*Woody Plants of the Southeastern United States, A Winter Guide* by Ron Lance. Cover photo is Flowering Dogwood (*Cornus florida*) by Hugh & Carol Nourse of Athens, Ga.

Publication date: Oct. 15, 2004 • ISBN 0-8203-2524-4 • $54.95 cloth • 441 pages • University of Georgia Press, Athens, Georgia • Tel: 706-369-6130 • www.ugapress.org

Finally we have an excellent new book for those of us who like to be able to identify our plant friends all year round, even in the dead of winter! This book has many exciting attributes which makes it a valuable reference for everyone's library:

1. the very fact that it will enable you to identify almost all woody plant species with winter characteristics such as twigs and fruit;
2. it includes all native and naturalized woody plant species that you are likely to encounter;
3. it covers the entire southeastern United States from northern Florida to eastern Texas, and from southeastern Kansas, to southern Delaware;
4. all illustrations were drawn by the author;
5. the book was written by one of the South's premiere woody plant experts, Ron Lance.

Ron has spent at least eighteen years and has traveled many, many miles across the southeast acquiring the knowledge necessary to publish this book. He has tried to find, inspect, collect, study, photograph, illustrate, and record, as nearly as possible the totality of our native woody flora. His book contains the fruit of all these years of labor. Ron has included extensive

dichotomous keys, illustrations, and condensed identification information to aid in identifying woody plants of the southeast in winter for 695 native species and varieties, and 189 exotic species and varieties. In addition to these 884 plant taxa, the author has mentioned 123 other varieties that are not presented in the identification process. For those plants that cannot be identified by winter characteristics alone, the summer features are included.

The layout of the book is very practical with the Preface, followed by the Introduction, Master Keys to Genera, Descriptive Text and Keys to Species, Glossary of Terms Used in This Text, References, and Index. The Introduction is especially good and is divided into eighteen sections, including a very informative section on *twig terminology* which is a must section for identifying woody plants in winter. This section also has some nice illustrations by the author of different types of buds, leaf scars, bundle scars, and the different types of twig piths. Next we have twenty seven pages of keys, followed by the largest section of the book, the Descriptive Text and Keys to Species, which also contains all the illustrations. Mr. Lance also includes very extensive glossary and references sections.

Since Ron is the only person we know of who is an expert on *Crataegus* (Hawthorns), we were a little disappointed that he didn't include a full treatment of this difficult genus in this work, but then we realized that this would be impossible in a winter only guide so we will look forward to that publication in the near future. This book is highly recommended to those wishing to further their knowledge of trees and shrubs of the southeast. This book represents a major event in the history of woody plant taxonomy.

Ron Lance is the nursery curator at Chimney Rock Park in North Carolina. His previous books include *Hawthorns and Medlars*. Mr. Lance has worked for more than twenty-five years in the fields of botany, zoology, and horticulture in such roles as instructor, specimen collector, field technician, researcher, and manager of horticultural facilities.

*Reviewed by Richard Ware*

# Contributors

Heather Alley is Lab Coordinator for the Plant Conservation Program at the State Botanical Garden of Georgia and Project Coordinator for the Botanical Guardians project of Georgia Plant Conservation Alliance. Heather received her M.S. degree from the University of Georgia Department of Horticulture in 2002. Her research interests include rare plant propagation, habitat restoration, and endangered species safeguarding and monitoring.

Richard Carter is a field and herbarium botanist at Valdosta State University where he has been on the faculty since 1984. At Valdosta State, he teaches a variety of botany courses and is curator of the herbarium. His research deals mostly with systematics of sedges, particularly *Cyperus* and *Eleocharis*; the flora of the coastal plain of Georgia; and invasive weeds.

Cindy Reittinger is the Interpretive Specialist for the Georgia Department of Natural Resources, Parks and Historic Sites Division. Before joining the DNR staff in 2001 she spent eight plus years as the Education Director at the Atlanta Botanical Garden. Her other work experience includes four years as a Biology Instructor at Purdue University and seasonal naturalist positions with the National Park Service and Ohio State Parks. Cindy earned an M.S. in Biology from Purdue University and a B.S. in Environmental Biology from Ohio University. She currently serves on the boards of the Georgia Exotic Pest Plant Council and the Environmental Education Alliance of Georgia.

Carol Schneier, Ph.D. is a past president of the Georgia Botanical Society. Since retiring from IBM, Carol has been an enthusiastic volunteer naturalist with federal, state and conservation organizations. Projects include rare plant surveys, plant inventories, nature trail construction, bird banding, dinosaur digs and archeological excavations.

*Echinacea laevigata*
Heather Alley

*Croomia pauciflora*
Leslie Edwards and Steve Bowling

*Scirpus cyperinus*
Richard Carter

*Kyllinga odorata*
Richard Carter

*Cyperus srigosus*
Richard Carter

*Fuirena breviseta*
Richard Carter